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Directional preference of the extremity: a preliminary investigation

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ABSTRACT

Background: Mechanical diagnosis and therapy (MDT) is a specific classification-based musculoskeletal examination and intervention system that uses repeated end range and sustained movement to classify patients into mechanical syndromes. Research has recently demonstrated increased prevalence, reliability, and efficacy of MDT syndromes in varied peripheral musculoskeletal populations. There is currently no research analyzing if predictive variables exist for establishing directional preference in peripheral joints, other than the wrist. The aim of this study was to examine the clinical application of predictive variables for establishing directional preference and spinal referral in patients with isolated peripheral joint pain.

Case Description: Thirty-seven consecutive patients with isolated peripheral pain were evaluated and classified using MDT assessment. Secondary analysis of predetermined variables was performed for association with directional preference and identification of spinal referral in Derangement syndrome.

Results: All 37 patients were classified using MDT assessment. Thirty-three (89.2%) were classified as Derangement syndrome: 17 as spinal Derangement (45.9%) and 16 as peripheral Derangement (43.2%). One peripheral derangement also had an underlying Articular Dysfunction. Additionally, there were four patients classified as Other (10.8%).

Discussion: Historical and physical examination findings were analyzed to determine if there were associated variables of directional preference or spinal referral. Mechanical stress was found to be the most associated factor in predicting directional preference. No peripheral movement loss, paresthesia, and constant pain were more associated with spinal referral. These findings may lead to a greater understanding of peripheral MDT assessment, which may lead to increased identification of directional preference and improved patient outcomes.

Level of Evidence: 4

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MDT; McKenzie; extremity; spinal referral; directional preference; derangement; classification

Introduction

Directional preference is a phenomenon that occurs in musculoskeletal disorders when one specific movement causes an improvement in pain, range of motion, strength, or function [1]. Directional preference was first described by Robin McKenzie in the management of spinal disorders [2] and has been researched extensively since [3]. Directional preference is also used in the McKenzie methods: mechanical diagnosis and therapy (MDT) for the management of extremity disorders [1]. Directional preference is associated with improved symptomatic and functional outcomes in spinal and extremity disorders [4–7]. MDT is an evaluation and treatment system that uses symptomatic and mechanical responses, rather than patho-anatomical diagnosis. Through repeated movement testing, musculoskeletal disorders are classified into the following syndromes: Derangement, Dysfunction, Postural, and Other (Table 1) [1,2].

Research has shown Derangement syndrome to closely parallel, or mimic, the patho-anatomical diagnoses lateral epicondylalgia [8], knee osteoarthritis [6], knee meniscus tear [9], shoulder rotator cuff tear [10–12], type 2 superior labrum anterior and posterior (SLAP) lesion [11], impingement of the acromioclavicular joint [11,12], de Quervain's disease [13], temporomandibular joint dysfunction [14], and ankle sprain, posterior tibialis tendonitis, plantar fasciitis, and metatarsophalangeal edema [15]. However, Derangement syndrome has a distinct management strategy that focuses on movement based classification, intervention, and prognosis as opposed to a patho-anatomical diagnosis [8].

The reported prevalence of MDT syndromes in peripheral joints includes the following: a survey finding 64% of 388 consecutive patients fitting an MDT syndrome [16], a randomized controlled trial finding 40% of 99 patients with knee OA awaiting total knee replacement surgery to be classified as Derangement syndrome [6], a case series finding 79% of 19 consecutive wrist patients classified as Derangement syndrome [17], and an observational study with 88.2% of 93 shoulder patients fitting an MDT classification [18]. A systematic review of six studies found the inter-rater reliability of MDT assessment to be acceptable between well-trained MDT clinicians in the spine and extremity joints [19]. Despite increasing research and

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Table 1. MDT syndromes.

Classification	Definition	Treatment Strategy
Derangement	• An internal dislocation of articular tissue of unknown origin which causes a disturbance in the normal resting position of the affected joint surface, resulting in pain and obstruction to movement	• Repeated movement in one direction, known as directional preference • Directional preference is associated with improvement in symptoms, and/or mechanical presentation (i.e. range of motion, strength, etc.) • Movement in the opposite direction may cause movement or symptoms to worsen and is known as directional vulnerability.
Dysfunction	• Mechanical deformation of structurally impaired soft tissue which results in pain and limited range of motion • The abnormal tissue can be a result of previous trauma, inflammatory, or degenerative processes that cause contraction, scarring, adherence, adaptive shortening, or imperfect repair. • Subcategorized into articular dysfunction and contractile dysfunction	• Progressive tissue loading to remodel the articular or contractile tissue
Postural Syndrome	• Non-pathological mechanical deformation of normal soft tissues or vascular insufficiency arising from prolonged positional stresses affecting the articular structures or the contractile muscles, their tendons, or the periosteal insertions	• Patient education and avoidance of the offensive position
Other	• Pain or condition of non-mechanical origin • Examples of these conditions include, but are not limited to, cancer, fracture, vascular pathology, chronic pain syndrome, trauma, soft tissue pathology, post-surgical, and inflammatory conditions	• Referral to appropriate physician or specialist

acceptable reliability, a survey of MDT clinicians reported lower confidence in using peripheral MDT assessment when compared to the spine [20].

In attempt to increase the ability and confidence of clinicians using MDT peripheral assessment, Maccio et al. [17] examined the historical and physical characteristics of consecutive wrist patients, to determine association with directional preference. The most significant finding was an inverse relationship of excessive mechanical stress and directional preference in wrist Derangement syndrome (i.e. 75% of patients exposed to excessive wrist extension required the opposite direction, wrist flexion, as directional preference) [17]. There is currently no research analyzing if predictive variables exist for establishing directional preference in peripheral joints, other than the wrist [17].

This study looked to determine if the same associations found at the wrist [17] were also applicable in all other peripheral joints. The aims of this study were to: (1) examine the occurrence of MDT syndromes in consecutive patients with isolated peripheral pain or peripheral medical diagnosis, (2) establish directional preference in patients classified as peripheral and spinal Derangement, (3) analyze if predetermined variables were associated with finding directional preference in peripheral joint Derangement, (4) determine if consistent characteristics exist to identify peripheral pain with spinal origin.

Methods

Two examiners were used for data collection, evaluation, and treatment of consecutive patients, who were either self-referred with isolated peripheral pain, or referred with a peripheral medical diagnosis from a primary care provider or specialist. The lead author (JRM) holds a doctorate in physical therapy and Diploma in MDT. At the time during which the study was conducted, the second examiner (KL) was a doctoral student of physical therapy and had been trained by the lead author in MDT extremity evaluation as part of a 10-week clinical affiliation. At the time the study was conducted, KL had taken MDT introductory cervical and lumbar continuing education courses. All patient management was overseen by the lead author. Bybee et al. [21] found MDT-trained physical therapist students to be as reliable as experienced clinicians trained in MDT for diagnosis and treatment of patients with neck pain. Acceptable treatment and clinical outcomes have been achieved by MDT-trained student physical therapists under the guidance and monitoring of skilled MDT clinicians in the elbow, wrist, and cervical spine [8,17,22].

Patients were recruited through the normal business operations of a private Certified McKenzie Clinic. Signed consent was obtained from all patients included in the study, and all anonymity and confidentiality was maintained.

Consecutive patients with complaint of extremity pain greater than or equal to 3/10 on the Numeric Pain Rating Scale (NPRS) were eligible for inclusion in the study. The NPRS is an 11-point scale where 0 designates 'No pain' and 10 designates 'The worst pain imaginable' [23]. No other inclusion or exclusion criteria were implemented. Data collection was performed over a 10-week period. The patients were evaluated using an MDT-based assessment, which involved repeated end range and sustained movement testing. While performing repeated end range and sustained movement testing, symptomatic (e.g. pain) and mechanical responses (e.g. strength, range of motion, and functional movements) were monitored. Range of motion loss was categorized as nil, minimal, moderate, and major loss [1,2].

Spinal involvement was first assessed using at least 10, and up to 50 or more, repetitions or sustained positioning of end-range cervical, thoracic, and lumbar movements. In some cases, high repetition was required before a positive criterion for establishing directional preference was detected (criteria listed below). In the case of upper extremity pain, both the cervical and thoracic spine were assessed with emphasis on the cervicothoracic junction as this has been found to be a source of upper extremity referral [22]. Clinician overpressure or mobilization was used if spinal involvement was suspected from historical or physical examination [1]. If symptomatic or mechanical extremity baselines were altered as the result of spinal movements, patients were determined to have spinal involvement. If the extremity baselines were unaffected through the spinal assessment, the patient was considered to have no spinal involvement and end-range extremity movements were tested [1]. The repeated end range extremity movements are referred to as loading strategies, which are intended to be end-range, self-joint mobilization techniques. They are described by the amount of weight-bearing (e.g. loaded, partially loaded, unloaded), the direction of movement (e.g. extension, flexion, etc.), and the external force (e.g. traction, overpressure, mobilization, manipulation) [1].

In an MDT examination, mechanical or symptomatic responses are tested in the sagittal plane first. If there is not a favorable response, alternative strategies are employed using repeated end range movement testing in the transverse or frontal planes [2]. The examiner performed movement testing until pain was abolished. If abolishment of pain did not occur, the movement that had the greatest reduction in pain was chosen as the patient's directional preference. If pain was not altered, the movement that had the greatest increase in range of motion or functional activity was chosen as the patient's directional preference [17]. The lead examiner reviewed all testing results before directional preference was prescribed.

Criteria for establishing directional preference included improvement in one or more of the following, as a direct result of movement testing:

- Improvement in resting pain or pain with active, passive, or resisted movement ≥ 2/10 NPRS
- Range of motion improvement ≥ 50%
- Improvement in ability to perform functional task by 50% (as reported verbally by the patient) or reduction in associated pain by ≥ 2/10 NPRS

Patients were classified into mechanical syndromes, and patients were managed without alteration of normal practice. The following predetermined variables [17] were analyzed for association, or inverse association, with directional preference of peripheral Derangement: mechanical stress, directional vulnerability, painful movement, and obstructed movement.

Operational definitions of analyzed variables:

- Mechanical stress – a repeated end range or sustained extremity movement that the patient performs more often than any other extremity movement
- Directional vulnerability – a repeated end range or sustained extremity movement the patient reports to reproduce their symptom
- Painful movement – the most painful movement rated on the NPRS
- Obstructed movement – the range of motion that is most limited when compared to the asymptomatic extremity

Variables analyzed for association in determining spinal or extremity referral were: detectable peripheral movement loss, paresthesia, detectable spinal movement loss, pain at rest, constant pain, intermittent symptoms with pain at rest, intermittent symptoms without pain at rest.

Operational definitions of analyzed variables:

- Detectable peripheral movement loss – difference in range of motion compared to the opposite, asymptomatic side
- Paresthesia – patient-reported numbness or tingling at the site of peripheral pain
- Pain at rest – report of pain that lingers for a variable duration of time, which could be provoked by movement or no apparent reason. This comprises constant pain and intermittent symptoms with pain at rest
- Constant pain – pain that does not ever reach 0/10 on the NPRS but can be variable from 1–10/10 on the NPRS
- Intermittent symptoms with pain at rest – variable pain that can reach 0/10 on the NPRS at times; however, patient can also have pain at rest with varying duration
- Intermittent symptoms without pain at rest – pain is only provoked during movement or activity and subsides to 0/10 on the NPRS when the provocative movement is stopped. The patient experiences no lingering pain at rest

Data were stored in an Excel Table. Once all patients successfully completed treatment, frequencies and percentage of occurrences were tabulated.

Results

Thirty-seven patients (25 female, 12 male) with peripheral pain were evaluated. Patient age ranged from 22 to 82 years (mean 55.2 ± 14.8). Duration of symptoms ranged from 2 to 208 weeks (mean 33.7 ± 43.9). NPRS ranged from 3/10 to 10/10 (mean 6.1 ± 1.9/10). Of the 37 evaluated patients, 26 were provisionally classified as Derangement syndrome (70.3%), 14 as spinal Derangement (37.8%), 12 as peripheral Derangement (32.4%), and 11 as Other (29.7%) (two post-trauma, one s/p surgery, and eight inconclusive) (Figure 1; Table 2). No Articular or Contractile Dysfunction, or Postural Syndromes were identified after initial assessment. Three patients had no response to repeated end range or sustained movements on Day 1 but later showed a positive response 24 to 72 h later. There were eight changes in classification and three changes in directional preference. The confirmed classifications of the 37 evaluated patients were the following: 33 Derangement syndrome (89.2%) – 17 as spinal Derangement (45.9%), 16 as peripheral Derangement (43.2%). One peripheral derangement also had an underlying Articular Dysfunction. Four patients were classified as Other (10.8%) (two post-trauma, one s/p surgery, and one inconclusive).

Seventeen (45.9%) patients had peripheral pain referred exclusively from spinal Derangement. Of these 17 patients, 12 (70.6%) had no detectable peripheral movement loss, 7 (41.2%) reported paresthesia, 9 (52.9%) had detectable spinal movement loss, and 16 (94.1%) reported that they could experience pain at rest. Nine patients (56.3%) had pain all the time (constant symptoms) with no periods of nil symptoms, and seven (43.8%) had intermittent symptoms with pain at rest. Only one patient (5.9%) had intermittent symptoms with no pain at rest (Figure 2).

Of the 16 (43.2%) patients with peripheral Derangement with nil spine referral, 2 (12.5%) had no peripheral movement loss, 0 reported paresthesia, and 11 (68.8%) had pain at rest. One of the 11 (9.1%) had constant symptoms, and 10 of those 11 (90.9%) had intermittent pain at rest. Five of the 16 (31.3%) patients had intermittent symptoms with no pain at rest (Figure 3).

Additionally, 29/33 (87.9%) of patients had a patho-anatomical diagnosis from a medical specialist. Of these patients, 45.9% had isolated peripheral pain generation exclusively from spinal referral, yet all received a patho-anatomical peripheral diagnosis from a medical specialist. This was most frequently observed in Orthopedic referrals (71%), compared to primary care referrals (16.7%).

Upon secondary analysis of collected patient data classified with peripheral Derangement syndrome, the highest association of directional preference was mechanical stress (Figure 4). Mechanical stress was inversely related to directional preference by 90% (9/10). The most obstructed movement matched directional preference by 53.8% (7/13), directional vulnerability inversely matched directional preference by 83.3% (10/12), and the most painful movement matched directional preference by 33.3% (5/15).

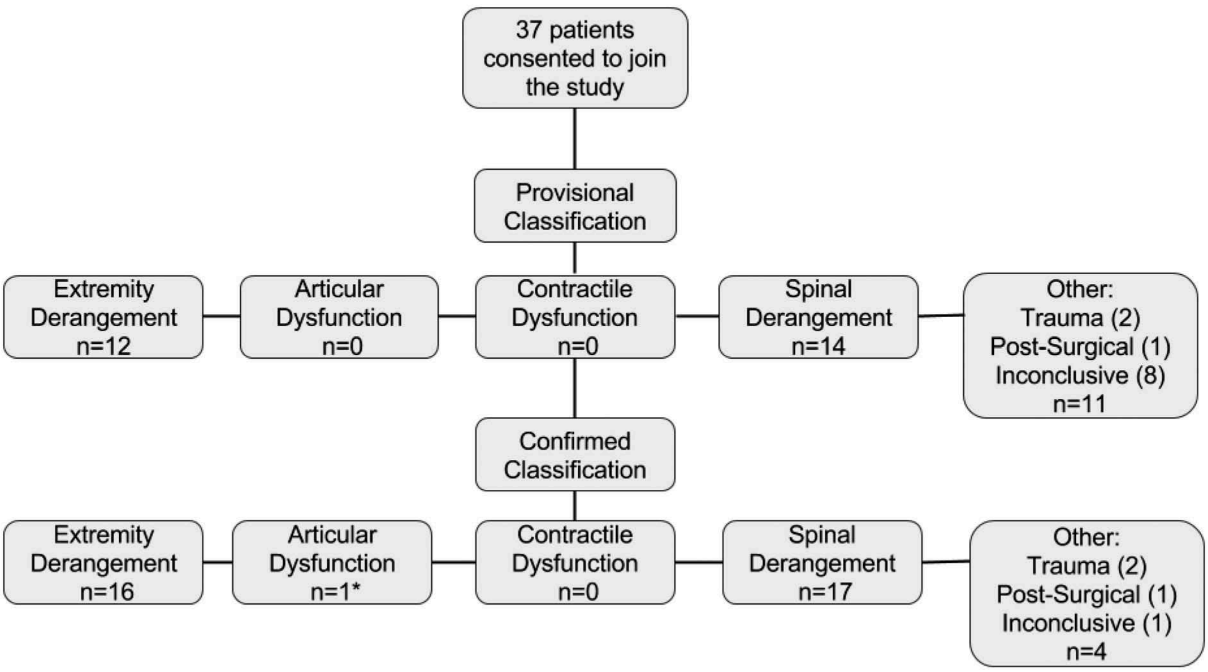

Figure 1. Prevalence of mechanical classifications.

Table 2. Patient diagnosis, classification, and directional preference.

Patient	Medical Diagnosis	Provisional MDT Classification	Confirmed MDT Classification	Directional Preference
1	None	Cervical Derangement	Shoulder Derangement	Shoulder Horizontal Adduction, Internal Rotation in 90 Degrees of Flexion
2	Right Knee Pain	Lumbar Derangement	Lumbar Derangement	Lumbar Extension in Standing/Lying
3	Shoulder Impingement, Tendonitis	Cervical Derangement	Cervical Derangement	Cervical Retraction/Extension with Thoracic Extension
4	Carpal Tunnel Syndrome	Inconclusive	Thoracic Derangement	Cervical Retraction/Extension with Thoracic Extension
5	Carpal Tunnel Syndrome	Wrist Derangement	Wrist Derangement	Wrist Extension, Flexion
6	Carpal Tunnel Syndrome	Cervical Derangement	Cervical Derangement	Cervical Retraction/Extension with Thoracic Extension
7	Trauma	Trauma	Trauma	N/A
8	Hip Bursitis	Inconclusive	Lumbar Derangement	Lumbar Extension
9	Hip Bursitis	Inconclusive	Lumbar Derangement	Lumbar Flex/Rotation
10	Ankle Fracture/Tendon Rupture Post-Surgery	Post-Surgical	Post-Surgical	N/A
11	Trauma	Trauma	Trauma	N/A
12	Shoulder Impingement/ Subacromial Bursitis/ Rotator Cuff Tendonitis	Shoulder Derangement	Shoulder Derangement	Shoulder Internal Rotation in 90 Degrees of Flexion
13	Patellofemoral Syndrome	Inconclusive	Knee Derangement	Unloaded Knee Extension
14	Carpal Tunnel Syndrome	Cervical Derangement	Cervical Derangement	Cervical Extension
15	Knee Arthritis**	Knee Derangement	Knee Derangement	Knee Extension/External Rotation
16	Cervical strain, neck, and back pain	Shoulder Derangement	Shoulder Derangement	Shoulder External Rotation in 90 Degrees of Flexion
17	Knee Arthritis	Inconclusive	Inconclusive	N/A
18	Bilateral hip and knee arthritis	Lumbar Derangement	Lumbar Derangement	Lumbar Extension
19	None	Knee Derangement	Knee Derangement	Partially Loaded Knee Flexion
20	Sciatica	Inconclusive	Hip Derangement	Hip Extension, Internal Rotation
21	Sciatica	Inconclusive	Hip Derangement	Partially Loaded Hip Extension
22	Shoulder Tendonitis	Shoulder Derangement	Shoulder Derangement	Shoulder Internal Rotation
23	2nd metatarsalgia	Lumbar Derangement	Lumbar Derangement	Lumbar Extension in Standing
24	Carpal Tunnel Syndrome	Thoracic Derangement	Thoracic Derangement	Sustained Thoracic/Cervical
25	None	Knee Derangement	Knee Derangement	Unloaded Knee Extension
26	None	Elbow Derangement	Elbow Derangement	Unloaded Elbow Extension
27	Psoas Strain	Lumbar Derangement	Lumbar Derangement	Unloaded Lumbar Extension
28	Knee Osteoarthritis	Lumbar Derangement	Lumbar Derangement	Lumbar Flexion in Sitting
29	Patellofemoral Syndrome	Knee Derangement	Knee Derangement	Unloaded Knee Extension
30	Ulnar Nerve Entrapment	Inconclusive	Thoracic Derangement	Thoracic Extension
31	Bursitis, Labral Tear	Shoulder Derangement	Shoulder Derangement	Shoulder Internal Rotation
32	Carpal Tunnel Syndrome	Cervical Derangement	Cervical Derangement	Cervical Retraction/Extension
33	Shoulder Impingement/ Rotator Cuff Pathology	Shoulder Derangement	Shoulder Derangement	Shoulder Extension in Internal Rotation
34	Trauma	Lumbar Derangement	Lumbar Derangement	Lumbar Extension
35	Hip Arthritis	Lumbar Derangement	Lumbar Derangement	Lumbar Side-Glide
36	SI Joint Pain/Dysfunction	Lumbar Derangement	Lumbar Derangement	Lumbar Flexion in Standing
37	Shoulder Impingement	Shoulder Derangement	Shoulder Derangement	Shoulder Horizontal Adduction

Discussion

The aim of this study was to establish predictive variables for identifying directional preference as well as determining clinical variables that are present when peripheral pain is of spinal origin. This study reports an 89.2% (33/37) occurrence (43.2% peripheral Derangement, 45.9% spinal Derangement) of MDT syndromes in 37 consecutive patients. This may demonstrate that MDT is an encompassing classification system for peripheral musculoskeletal pain; however, this needs to be studied in a larger sample size. Interestingly, 29/33 (87.9%) of these patients had a patho-anatomical diagnosis from a medical specialist. The presence of both an MDT and patho-anatomical diagnosis is most significant for those patho-anatomical conditions that have a degenerative or worsening prognosis, as the MDT classification Derangement is associated with positive short- and long-term prognosis [8]. Further, management of Derangement syndromes does not require medical or surgical intervention in comparison to the patho-anatomical diagnosis. This was most notably demonstrated by Rosedale et al., who reported a 40% prevalence rate of knee Derangement in patients with radiographic knee osteoarthritis on a wait-list for total knee replacement [6]. Given the cost-effective nature of MDT, significant short- and long-term cost savings in musculoskeletal care are likely. It has been demonstrated that the use of quality-controlled MDT for low back pain is capable of a risk-adjusted one-year cost savings of 39.8% [24]. Further research is required to determine if similar cost savings are possible in peripheral care.

This study found a high occurrence (45.9%) of peripheral pain in conditions that resolved fully with spinal treatment. It is unsettling and concerning to report this statistic as inaccurate identification of the source of pain generation could lead to an abundance of inappropriate diagnostic tests, as well as interventions (physical, chemical, surgical) directed to the wrong structure. An

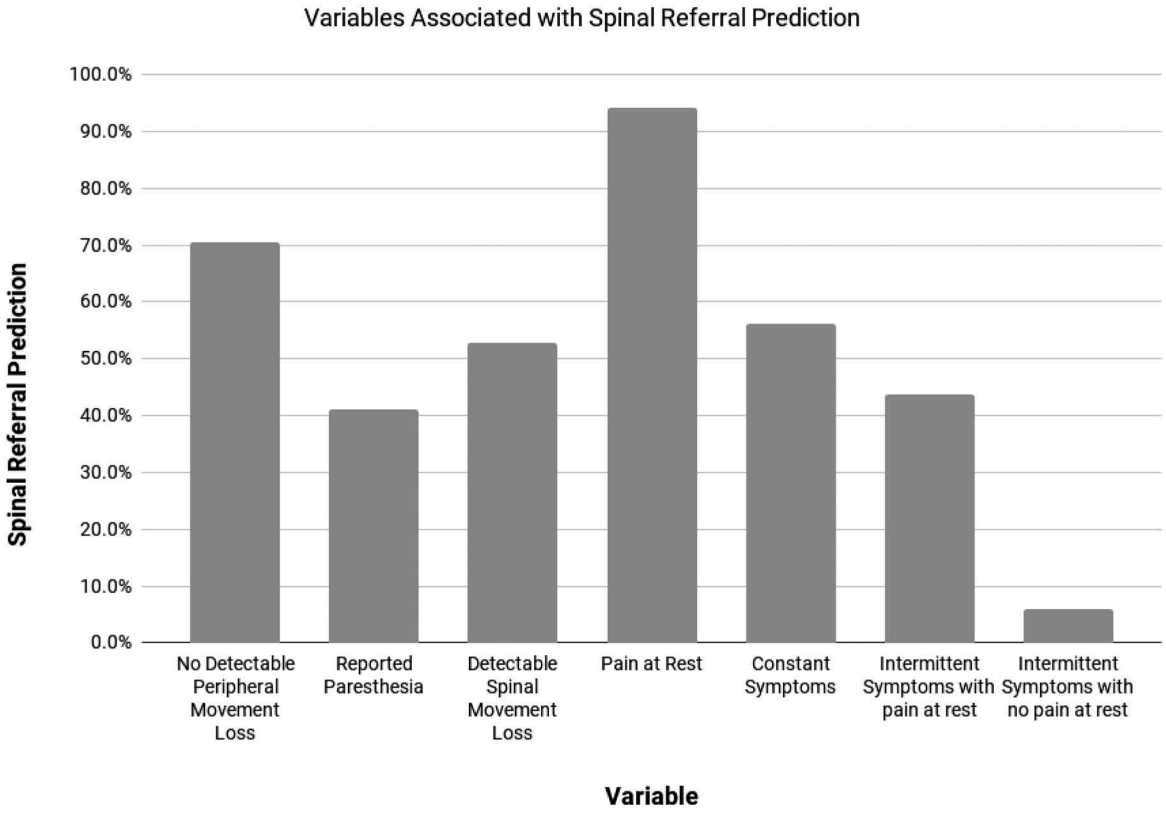

Figure 2. Variables associated with spinal referral prediction.

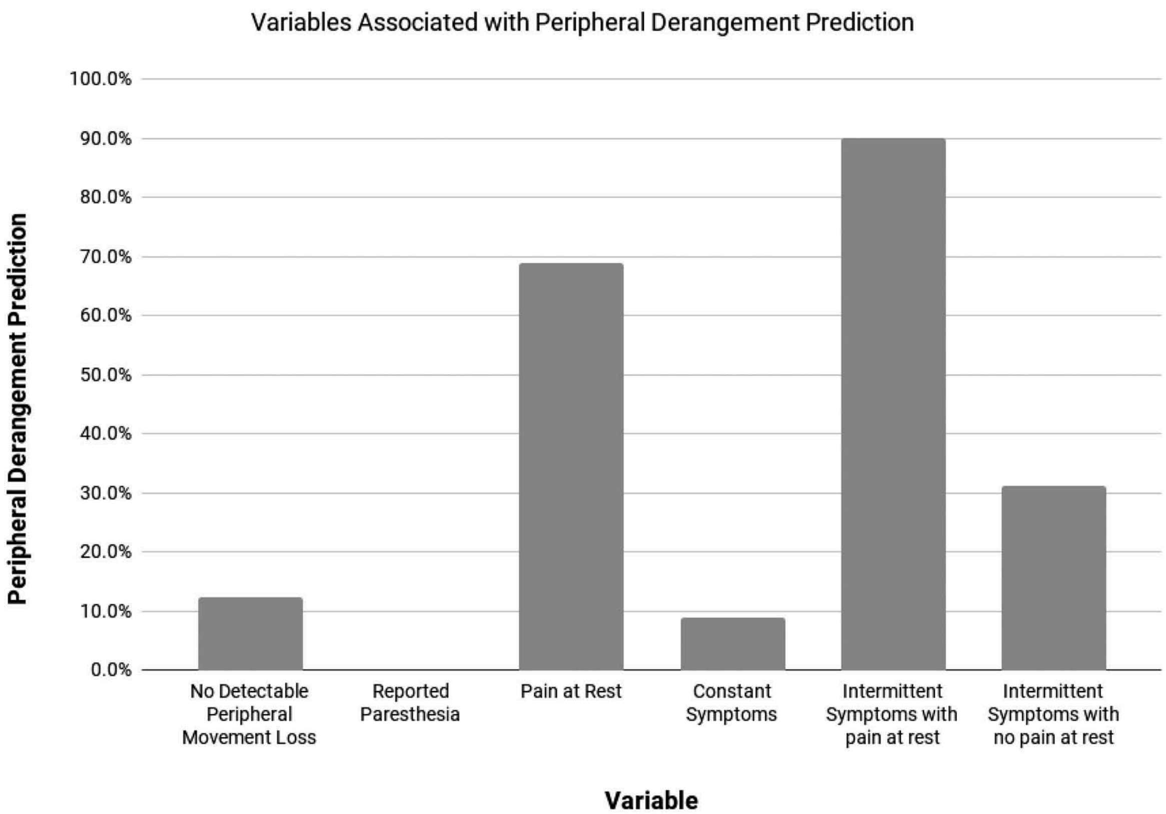

Figure 3. Variables associated with peripheral derangement prediction.

Orthopedic specialist was the highest source of peripheral medical diagnosis in this sample of which 71% were found to be of spinal origin. Consultation with an orthopedic specialist is viewed as the gold standard in diagnosis [1,25]; however, given a 71% error rate, this standard needs to be questioned. Reviews of current guidelines [26–30] have found inadequate standardized or validated spinal exclusion criteria. Further research

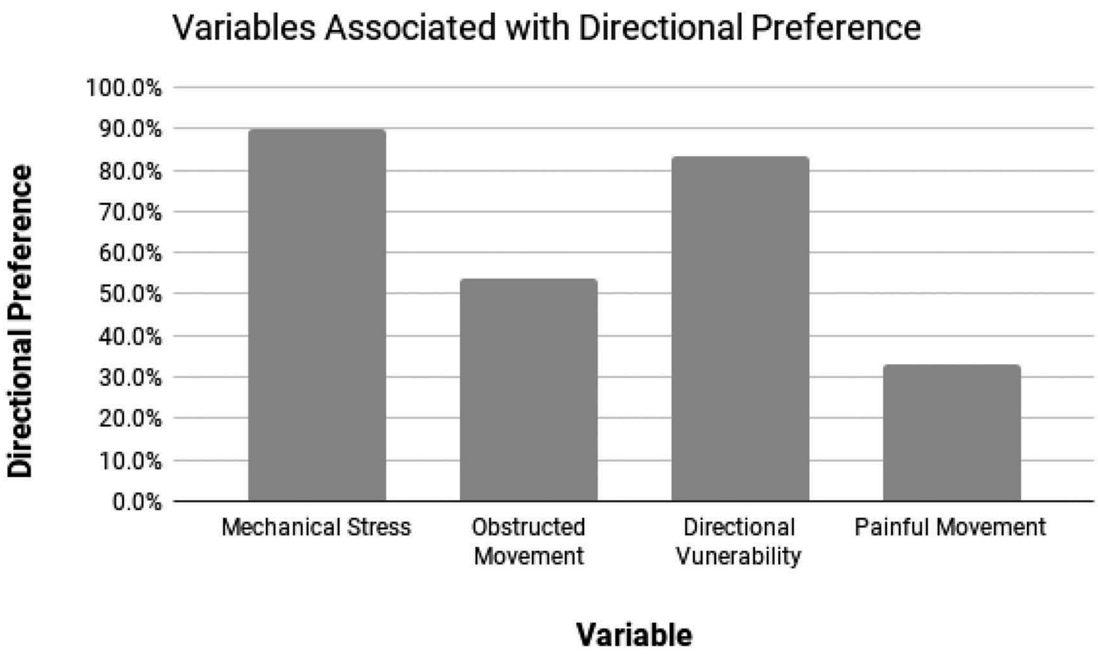

Figure 4. Variables associated with directional preference.

needs to be performed regarding this and before suggesting MDT as an effective screening tool.

Upon secondary analysis, the most associated factors to predict spinal referral were lack of peripheral movement loss and the presence of paresthesia. Spinal Derangement was more often present with constant pain (52.9%) and pain at rest (94.1%). Also of interest, only two patients with peripheral Derangement presented without detectable knee movement loss (12.5%). Both patients were classified with peripheral Derangement of the patella-femoral joint. The most associated factor in finding directional preference of peripheral Derangement was the inverse relationship of excessive mechanical stress (90%) and directional vulnerability (83.3%). This is more prevalent than the same analysis of these variables at the wrist, where the relationship between directional preference and mechanical stress, and directional vulnerability and directional preference, was also inverse at 73% and 66%, respectively [17].

A common pattern of this relationship was seen in patients who sat with their knee flexed for long periods of time, who reported worsening of symptoms with squatting and kneeling (knee flexion-based functional movements). These patients required the opposite movement, knee extension, as their directional preference. Conversely, for one patient who stood with his knee in extension for most of the day, extension worsened his pain. This patient also required the opposite movement, knee flexion, as his directional preference.

This study found 33% of patients required repeated end range movement testing into their most painful movement to establish directional preference. This practice is often uncomfortable for the patient and clinician and can be polarizing if a positive outcome is not achieved. Previous research has found repeated end range movement testing into the most painful movement to be required in 47.7% of consecutive wrist patients [17]. Other clinically relevant data was that many patients required over 50 repetitions or clinician overpressure and mobilization, before Derangement syndrome was confirmed. Three patients experienced no effect from repeated end range movement testing on initial evaluation; however, continued testing of the suspected reductive movement elicited directional preference over the course of 24 to 72 h. Additionally, 15 patients presented with peripheral upper extremity pain of which 7 were spinal referral. Of these seven patients, five (71.4%) required thoracic spine procedures exclusively or in conjunction with the cervical spine, which is far greater than McKenzie's original 1.96% prevalence of thoracic involvement [31]. This study found that the thoracic spine can have involvement in upper extremity disorders and therefore must be investigated further. If these clinical factors were not utilized, directional preference would have likely been present within the condition but never discovered, reducing the prevalence rate.

A limitation of this study is its small sample size. This reduces the potential generalizability of our data as well as limits any definitive prevalence or statistically supported values that may be clinically applicable at this time. Despite that, this study did identify variables that may be able to predict or infer directional preference; however, this needs to be studied under a larger sample size with proper statistical analyses before more definitive statements and conclusions can be made. It should also be noted that the findings of this study are comparable to those established at the wrist [17], indicating that MDT may be an encompassing classification system for peripheral musculoskeletal pain and should be studied in a larger sample size to improve generalizability and establish more robust statistical conclusions.

Conclusion

The mechanical patterns found in this study (e.g. inverse relationship between mechanical stress and directional preference, most obstructed movement matching directional preference, directional vulnerability inversely matching directional preference) might allow for easier detection of directional preference. These types of patterns have been widely documented in MDT spinal management but have yet to be identified in peripheral management. This may be one of the reasons MDT clinicians have shown high levels of agreement when using mock vignette forms [32] yet have poor agreement and lack of confidence when successive peripheral evaluation is performed [33]. Further research is required, including comparative efficacy in skilled and unskilled clinicians, with greater sample sizes, which are limitations of this study.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Joseph R. Maccio is a doctor of physical therapy and holds a diploma in Mechanical Diagnosis and Therapy (MDT). He is published in the application of MDT in the wrist, hip osteoarthritis, ankle, after failed anterior cervical fusion and discectomy, and lateral epicondylagia. He has given a platform presentation at the McKenzie Americas Conference detailing the prevalence of directional preference at the wrist. He has also presented numerous posters at national and international MDT conferences regarding ankle, lumbar, cervical, elbow, and hip pain. He has also presented a clinical mentoring webinar for the McKenzie Institute USA on the identification of derangement and directional preference. He is the Clinical Instructor (CI) for a MDT-specific clinical rotation for doctoral physical therapy students.

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References

[1] McKenzie R, May S. The human extremities: mechanical diagnosis and therapy. 2nd ed ed. Wellington, New Zealand: Spinal Publications New Zealand; 2003.
[2] McKenzie R. The lumbar spine: mechanical diagonsis and therapy. 1st ed ed. Wellington: Spinal Publications New Zealand Ltd; 1981.
[3] May S, Aina A. Centralization and directional preference: a systematic review. Man Ther. 2012;17(6):497–506.
[4] Long A, Donelson R, Fung T. Does it matter which exercise? A randomized control trial of exercise for low back pain. Spine. 2004;29(23):2593–2602.
[5] Long A, May S, Fung T. Specific directional exercises for patients with low back pain: a case series. Physiother Can. 2008;60(4):307–317.
[6] Rosedale R, Rastogi R, May S, et al. Efficacy of exercise intervention as determined by the McKenzie system of mechanical diagnosis and therapy for knee osteoarthritis: a randomized controlled trial. J Orthop Sport Phys Ther. 2014;44(3):173–181.
[7] Edmond SL, Cutrone G, Werneke M, et al. Association between centralization and directional preference and functional and pain outcomes in patients with neck pain. J Orthop Sports Phys Ther. 2014;44(2):68–75.
[8] Maccio JR, Fink S, Yarznbowicz R, et al. The application of mechanical diagnosis and therapy in lateral epicondylalgia. J Man Manip Ther. 2016;24(3):158–165.
[9] Lynch G, May S. Directional preference at the knee: a case report using mechanical diagnosis and therapy. J Man Manip Ther. 2013;21(1):60–66.
[10] Menon A, May S. Shoulder pain: differential diagnosis with mechanical diagnosis and therapy extremity assessment - a case report. Man Ther. 2012;18(4):4–7.
[11] Kidd J. Treatment of shoulder pain utilizing mechanical diagnosis and therapy principles. J Man Manip Ther. 2013;21(3):168–173.
[12] Aytona MMC, Dudley K. Rapid resolution of chronic shoulder pain classified as derangement using the McKenzie method: a case series. J Man Manip Ther. 2013;21(4):207–212.

[13] Kaneko S, Takasaki H, May S. Application of Mechanical Diagnosis And Therapy to a patient diagnosed with de Quervain's disease: a case study. J Hand Ther. 2009;22(3):278–284.
[14] Krog C, May S. Derangement of the temporomandibular joint; a case study using Mechanical Diagnosis and Therapy. Man Ther. 2012;17(5):483–486.
[15] Carlton L, Maccio JR, Maccio JG, et al. The application of Mechanical Diagnosis and Therapy to the ankle-foot complex: a case series. J Man Manip Ther. 2018;
[16] May SJ, Rosedale R. A survey of the McKenzie classification system in the extremities: prevalence of preferred loading strategies. JOSPT. 2012;92(9):1175–1186.
[17] Maccio JR, Carlton L, Fink S, et al. Directional preference of the wrist: a preliminary investigation. J Man Manip Ther. 2017;25(5):244–250.
[18] Abady AH, Rosedale R, Chesworth BM, et al. Application of the McKenzie system of Mechanical Diagnosis and Therapy (MDT) in patients with shoulder pain; a prospective longitudinal study. J Man Manip Ther. 2017;25(5):235–243.
[19] Takasaki H, Okuyama K, Rosedale R. Inter-examiner classification reliability of Mechanical Diagnosis and Therapy for extremity problems – systematic review. Musculoskelet Sci Pract. 2017;27:78–84.
[20] Takasaki H, Iwasada Y, May S. Attitude towards the use of Mechanical Diagnosis and Therapy and reliability of classification extremity problems by credentialed therapists. J Chiropr Med. 2015;14(1):32–38.
[21] Bybee R, Dionne C. Interrater agreement on assessment, diagnosis, and treatment for neck pain by trained physical therapist students. J Phys Ther Educ. 2007;21(2):39–47.
[22] Carlton L, Maccio JR, Handford J, et al. The application of Mechanical Diagnosis and Therapy in failed Anterior Cervical Discectomy and Fusion : a case report. Orthop Rhematology. 2017;9:4.
[23] Stratford P, Spadoni G. The reliability, consistency and clinical application of numeric pain rating scale. Physther Can. 2001;281:259–266.
[24] Donelson RG, Spratt KF. The impact of a precise mechanical diagnosis for low back pain: a cost comparison with standard community care. Spine J. 2016;16(10):S301.
[25] Cyriax J. Volume one. diagnosis of soft tissue lesions. In: Textbook of orthopaedic medicine, 8th. 1982. London: Bailliere Tindall;
[26] Lesher JD, Sutlive TG, Miller G, et al. Development of a clinical prediction rule for classifying patients with patellofemoral pain syndrome who respond to patellar taping. J Orthop Sports Phys Ther. 2006; 36(11):854–866.
[27] Currier LL, Froehlich PJ, Carow SD, et al. Development of a clinical prediction rule to identify patients with knee pain and clinical evidence of knee osteoarthritis who demonstrate a favorable short-term response to hip mobilization. Phys Ther. 2007;87(9):1106–1119.
[28] Mintken P, McDevitt A, Michener L, et al. Examination of the validity of a clinical prediction rule to identify patients with shoulder pain likely to benefit from cervicothoracic manipulation. JOSPT. 2017; 47(4):252–260.
[29] Sutlive TG, Lopez HP, Schnitker DE, et al. Development of a clinical prediction rule for diagnosing hip osteoarthritis in individuals with unilateral hip pain. JOSPT. 2008;38(9):542–550.
[30] Kuijpers T, Dawm VDW, Boeke AJP, et al. Clinical prediction rules for the prognosis of shoulder pain in general practice. Pain. 2006;120(3):276–285.
[31] McKenzie R. The cervical and thoracic spine: mechanical Diagnosis and Therapy. 1st ed ed. Waikanae, New Zealand: Spinal Publications New Zealand, Limited; 1990.
[32] Abady AH, Rosedale R, Overend TJ, et al. Inter-examiner reliability of diplomats in the Mechanical Diagnosis and Therapy system in assessing patients with shoulder pain. J Man Manip Ther. 2014; 22(4):199–205.
[33] Takasaki H. Agreement of Mechanical Diagnosis and Therapy classification in people with extremity conditions. J Phys Ther. 2016;96(10):1525–1532.